NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

UNDERGROUND OUTLET

(Feet)

CODE 620

DEFINITION

A conduit installed beneath the surface of the ground to collect surface water and convey it to a suitable outlet.

PURPOSE

Dispose of excess water from terraces, diversions, subsurface drains, surface drains, trickle tubes or principal spillways from dams (outside the dam area only), or other concentrations without causing damage by erosion or flooding.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies where:

(1) excess surface water needs to be disposed of;

(2) a buried outlet is needed for Diversions (362), Terraces (600), or similar practices;

(3) an underground outlet can be installed that will safely dispose of excess water; and

(4) surface outlets are impractical because of stability problems, climatic conditions, land use, or equipment traffic.

This practice is not applicable where construction would destroy woody wildlife cover and the present or future outlet is capable of handling the concentrated runoff without serious erosion. Such situations are usually recognized by a meandering condition, steep side slopes which are stabilized by woody plants or herbaceous vegetation, and the watercourse is without rapidly advancing overfalls. Where wetlands will be affected, the cooperator will be advised and current NRCS wetland policy will apply. Refer to NRCS booklet "Wetland Types in Missouri," or Fish and Wildlife Circular 39 for classification.

CRITERIA

Capacity. The underground outlet shall be designed, alone or in combination with other practices, with adequate capacity to insure that the terrace, diversion, or other practices function according to the standard for the specific practice. For example, an underground outlet can be used in combination with a grassed waterway or a surface drain to carry part of the design flow. The capacity of the underground outlet for natural or constructed basins shall be adequate for the intended purpose without causing excessive damage to crops, vegetation, or improvements.

The minimum discharge capacity for underground outlets shall be sufficient to remove water from the storage basin in 48 hours or less. Release times of less than 24 hours may be required to prevent damage to specific crops from prolonged inundation.

Conduit line capacity downstream from any non-orificed inlet in a multiple inlet line shall be increased a minimum of 0.05 cubic feet per second per inlet-acre over the flow in the conduit upstream from the respective inlet.

When an underground outlet is the only practice removing the design runoff, the minimum basin storage volume for the 10-year frequency 24-hour storm may be obtained from the Missouri supplement to NRCS, National Engineering Handbook (NEH), Part 650, Engineering Field Handbook (EFH), Chapter 8 - Terrace.

Inlet. An inlet can be a collection box, a

perforated riser, or other appropriate device. Its capacity shall be adequate to provide the maximum design flow in the conduit. Flow-control devices shall be installed as necessary. Perforated risers must be of durable material, structurally sound, and resistant to damage by rodents or other animals. If burning of vegetation is likely to create a fire hazard, the inlet shall be fire resistant. Blind inlets can be used where they are effective. Collection boxes must be large enough to facilitate maintenance and cleaning operations. The inlet must have an appropriate trash guard to insure that trash or other debris entering the inlet passes through the conduit without plugging. It must also have an animal guard to prevent the entry of rodents or other animals.

Inlets shall have a minimum inside diameter of 6 inches. The inlet or inlet holes shall not be used to control discharge. All intake openings shall be smooth and burr free. The inlet capacity shall be equal to or greater than the design discharge rate used to compute basin storage volume. The inlet capacity shall be calculated assuming at least 50% of the openings on the side of the inlet are plugged and the water surface is at a maximum of 70% of the maximum ridge height.

Table 2 in the Missouri Supplement to EFH, Chapter 8 - Terrace may be used to select an adequate inlet.

Inlet caps or screens shall be removable on inlets with orifice plates. The maximum screen opening dimension shall not exceed one half (1/2) the orifice diameter on inlets with orifices.

Orifice plates, when used, shall be made of metal or durable plastic, fit tight against the seat of connectors and have a smooth edge. Use the exhibit in EFH, Chapter 8 -Terrace to determine capacity of orifice plates. Appropriate equations should be used to determine the capacity of other types of devices which restrict flow. Submergence of the orifice will reduce the orifice head. Use the reduced head to determine submerged orifice capacity.

Pressure-relief wells shall be designed and installed as needed to control pressure (See Vertical Outlet section for design requirements). Pressure may also be controlled by restricting flow into the conduit or by increasing conduit size at grade changes.

If junction boxes and other structures are needed, they shall be designed and installed in a manner that facilitates cleaning and other maintenance activities.

Hydraulics. Underground outlets shall be continuous conduits, tubing, or tile. Joints shall be hydraulically smooth, and the materials and methods used shall be recommended by the manufacturer. If a pressure system is used, joints shall be adequate to withstand the design pressure, including surges and vacuum. The maximum velocity must not exceed the safe velocity for the conduit materials and installation. Maximum permissible velocities are shown in Table 1 of the Missouri Supplement to EFH, Chapter 8 - Terrace.

Lines shall be adequate to carry the design flow when the outlet and all inlets are operating at design capacity. Positive grade shall be maintained in all sections of an underground outlet. Capacity shall be based on the pipe size or on other flow control devices to prevent water from the upper inlets from discharging through the lower inlets. The minimum conduit diameter shall be 4 inches.

The hydraulic grade line (HGL) between successive inlets will approximate the difference in ground elevations at the inlets for:

(a) all inlets orificed

(b) no inlets orificed

The HGL slope must be determined if there is a mixing of inlets with and without orifice plates on a conduit line. Orifices when mixed with non-orificed inlets must be checked for submergence. Vertical drop from the last inlet to the outlet flow line should be used to determine HGL slope for that section. Vertical drop in this section should be taken from the maximum water surface elevation at the last inlet for a non-orificed inlet and from the orifice elevation for an orificed inlet. The vertical drop shall be corrected for tailwater and for special outlet installations.

Changes in conduit diameter on pressure systems shall be made at the tee joint immediately upstream from the inlet to prevent constriction in outlet flow. The tee diameter must be equal to or greater than the diameter of the conduit downstream from the inlet.

Conduit line capacity will be determined by using the information in the Missouri Supplement to EFH, Chapter 8 - Terrace. Manning's "n" (coefficient of roughness) values are:

0.011 - smooth plastic pipe

0.015 - smooth steel or corrugated plastic tubing 4 to 8 inch diameter

0.017 - corrugated plastic tubing 10 to 15 inch diameter

0.025 - corrugated metal pipe

Materials. Materials shall meet or exceed the design requirements against leakage and shall withstand internal pressure or vacuum and external loading. Plastic, concrete, aluminum, and steel shall meet the requirements specified in the applicable ASTM standard. All materials specified for Subsurface Drains (606) can be used for underground outlets. Conduits, however, can be perforated or nonperforated, depending on the design requirements. A filter fabric wrap (sock) or equivalent shall be used if migration of soil particles around conduit is anticipated. All exposed plastic materials shall be protected from degradation due to exposure to sunlight.

The fill height over the plastic pipe or tubing shall not exceed the values shown in Appendix A of EFH, Chapter 14 - Drainage or as computed by NRCS procedures contained in Part 636 National Engineering Handbook **Chapter 52 Structural Design of Flexible.**

Outlet. The outlet shall be sufficiently stable for all anticipated flow conditions. It shall be designed for the maximum anticipated water surface at design flow. A continuous section of closed conduit or a headwall can be used at the outlet. If a closed conduit is used, it shall be durable and strong enough to withstand all anticipated loads, including those caused by ice. Outlets shall not be placed in areas of active erosion. If fire is a hazard, the outlet shall be fire resistant. All outlets must have animal guards to prevent the entry of rodents or other animals. Animal guards must be hinged to allow passage of debris.

Vertical Outlet. A vertical outlet can be used to discharge water to the ground surface and reduce conduit size downstream where steep slopes change to flatter sections, where topography does not allow adequate conduit cover using a horizontal outlet, or where it is practical to discharge over vegetated filter strips.

An adequate and stable surface outlet for the design outflow rate and velocity shall be provided for the overflow from the vertical outlet. When a vegetated channel or waterway is to be used for the overflow, vegetation shall be established prior to installing the underground outlet. The minimum vertical outlet size shall be one conduit size larger than the incoming underground line. In the case of multiple lines entering the relief well, the cross sectional area of the relief well shall be at least 1.5 times the sum of the cross sectional areas of the incoming lines. In no case shall the relief well diameter be smaller than 6 inches. Relief well diameter shall be large enough to provide enough space along the circumference of the relief well for fabricating tile stubs (both incoming and outgoing lines) and allow for proper maintenance. The relief well shall extend at least to the ground surface but no more than 6 inches above the surrounding ground surface. The minimum depth from ground surface to relief well bottom shall be that which will provide the required depth of cover for the attached tile lines.

Vertical outlets and relief wells require adequate grating for safety and operation and maintenance purposes.

Protection. All disturbed areas shall be reshaped and regraded so that they blend with the surrounding land features and conditions. Visual resources must be given the same consideration as other design features. Areas that are not to be farmed or covered by structural works shall be established to vegetation or otherwise protected from erosion as soon as practicable after construction.

CONSIDERATIONS

Consider effects on the water budget, especially on volumes and rates of runoff, infiltration, evaporation, transpiration, deep percolation, and ground water recharge.

Consider effects on the volume of downstream flow that might cause undesirable environmental, social, or economic effects.

Evaluate potential use for water management.

Consider effects on erosion and the movement of sediment, pathogens, and soluble and sediment-attached substances that would be carried by runoff.

Consider effects on the visual quality of downstream water resources.

Consider the construction-related effects on the quality of downstream watercourses.

Consider effects on wetlands or water-related wildlife habitats.

Evaluate potential impact on water quality due to agri-chemicals in outflow.

Consider depth of underground outlet in regard to tillage equipment depth and maintenance, if applicable. If UGO depth of cover exceeds 4 feet consider a more structurally sound material.

If any crops grown in a rotation are sensitive to inundation, consider shorter removal time period.

PLANS AND SPECIFICATIONS

Plans and specifications for installing underground outlets shall be in keeping with this standard and shall describe the requirements for installing the practice to achieve its intended purpose.

OPERATION AND MAINTENANCE

An operation and maintenance plan shall be developed. University of Missouri Agricultural Guide Sheet 1501, "Operating and Maintaining Underground Outlet Terrace Systems" provides information on the operation and maintenance of underground outlets.

Underground outlets shall be maintained by:

- Keeping inlets, trash guards, and collection boxes and structures clean and free of materials that can reduce the flow
- Repairing leaks and broken or crushed lines to insure proper functioning of the conduit
- Checking outlet conduit and animal guards to ensure proper functioning of the conduit
- Keeping adequate backfill over the conduit
- Repairing any eroded areas at the pipe outlet

NATURAL RESOURCES CONSERVATION SERVICE
OPERATION AND MAINTENANCE

FOR

UNDERGROUND OUTLET

INLET
(feet)
CODE 620

Operation and Maintenance

The following University of Missouri Agricultural Guide provides information on the operation and maintenance of underground outlets:

1501 "Operating and Maintaining Underground Outlet Terrace Systems".

Additional Details: _____

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NATURAL RESOURCES CONSERVATION SERVICE
OPERATION AND MAINTENANCE

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Operation and Maintenance

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NATURAL RESOURCES CONSERVATION SERVICE
MISSOURI MATERIAL SPECIFICATION

FOR
UNDERGROUND OUTLET
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Materials

Inlets may be fabricated from plastic or metal according to the following requirements:

(a) Smooth Plastic Pipe:

(1) Polyvinyl Chloride (PVC) with SDR or DR equal to 41 or less conforming to ASTM D1785, D2241, D3034 or AWWA C900.

(2) High Density Polyethylene (HDPE) with SIDR, SDR, or DR equal to 21 or less conforming to ASTM D2239, D3035, or F714.

(3) Molded inlets made of PVC or HDPE shall be of equivalent strength to the pipes listed in (1) or (2).

(b) Corrugated Plastic Tubing:

(1) Polyethylene (PE) Smooth Interior AASHTO-M-294, Type S. Pipe stiffness equals 30 pounds per square inch at 5% deflection and 25 pounds per square inch at 10% deflection.

(2) Polyvinyl Chloride (PVC) Sewer Pipe with a Smooth Interior conforming to ASTM F949. Pipe stiffness equals 46 pounds per square inch at 5% deflection.

(c) Metal pipe:

Smooth steel pipe with 3/16" minimum wall thickness or 16 gage corrugated metal pipe (galvanized or aluminum).

All plastic inlets shall include an ultra-violet stabilizer or coating to protect from solar degradation.

Fabrication

Inlet holes shall be smooth and burr free. Holes shall not remove more than 50 percent of material in any horizontal or vertical row of holes. For inlets fabricated from metal or smooth plastic, 1" x 4" slots may be used in lieu of 1" diameter holes as long as the openings provide an equal cross-sectional area.

Holes larger than 5/16" diameter that are more than 6 inches below the channel bottom shall be covered with plastic, fiberglass, nylon, gravel or other filter material to prevent soil from entering the inlet.

Other combinations of the number and size of holes may be acceptable if approved prior to fabrication. Other materials and methods of fabrication may be used for the inlet, tee and other appurtenances as long as the functional intent of the inlet is satisfied and it is approved prior to installation.

Orifices

Flow may be restricted by use of an orifice plate installed above the tee. It should be firmly supported and able to be removed for maintenance. Orifice plates shall be made from durable plastic or metal. The opening shall be burr free.

Trash Guards

The trash guard for Type II inlets shall be securely fastened to the inlet. Trash guards may be fabricated from metal rods (1/4" diameter or larger) or galvanized welded wire fabric (16 gage or larger). The spacing between vertical members should be 1 inch. If welded wire fabric is used, the spacing between the horizontal members should be 2 inches (1 inch if orifice plates are used.)

As approved by NRCS, other equivalent designs may be used.

Installation

Refer to construction drawings and specifications for installation details.

Additional Details: _____

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Maximum fill height over plastic pipe or tubing = _____ feet

Minimum fill height over plastic pipe or tubing prior to tamping with construction equipment or crossing with heavy equipment such as a loaded scraper = _____ feet

NATURAL RESOURCES CONSERVATION SERVICE
MISSOURI CONSTRUCTION SPECIFICATION

FOR
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General

Construction operations shall be carried out in a manner and sequence that erosion and air and water pollution are minimized and held within legal limits.

The completed job shall present a workmanlike appearance and shall conform to the line, grades, and elevations shown on the drawings or as staked in the field.

All operations shall be carried out in a safe and skillful manner. Safety and health regulations shall be observed and appropriate safety measures used.

Materials

Conduits shall be plastic or metal pipe or tubing conforming to the following requirements:

(a) Smooth Plastic Pipe:

(1) Polyvinyl Chloride (PVC) with SDR or DR equal to 41 or less conforming to ASTM D1785, D2241, D3034 or AWWA C900.

(2) High Density Polyethylene (PE) with SIDR, SDR, or DR equal to 21 or less conforming to ASTM D2239, D3035, or F714.

(b) Corrugated Plastic Tubing:

(1) Polyethylene (PE) Heavy Duty conforming to ASTM F405, F667 AASHTO-M-252 or AASHTO-M-294. Pipe stiffness equals 30 pounds per square inch at 5% deflection and 25 pounds per square inch at 10% deflection.

(2) Polyvinyl Chloride (PVC) Sewer Pipe with a Smooth Interior conforming to ASTM F949. Pipe stiffness equals 46 pounds per square inch at 5% deflection.

(c) Metal Pipe:

Smooth steel pipe with 3/16" minimum wall thickness or 16 gage corrugated metal pipe (galvanized or aluminum).

Trench excavation

Unless otherwise shown in the "Additional Details" section of this specification, the trench excavation shall be sufficient to provide 24 inches or more cover over all conduit lines except metal pipe. The cover over metal pipe shall be 12 inches or more.

The bottom of the trench shall be grooved for proper conduit bedding. The groove should be at the side of the trench when backhoes are used. Maximum trench width shall be 24 inches measured 12 inches above top of conduit. Minimum trench width shall be conduit outside diameter plus four (4) inches except when the trench is shaped to fit the conduit.

A properly sized mole plow may be used.

Installation

Underground outlet systems shall be installed as shown on the construction drawings. Conduits shall be installed with a positive grade toward the outlet throughout their entire length. Conduit lines should be installed and properly backfilled prior to placement of earth fill for the storage basin or terrace ridge.

Provide at least 2 inches of compacted earth or sand filter bedding when the conduit line is to be installed in a rock trench or where rock is exposed in the trench bottom.

Changes in conduit line size shall be made at the tee joint immediately upstream from the inlet. The tee diameter must be equal to or larger than the diameter of the conduit line downstream from the inlet.

Conduit lines shall be joined with standard factory couplers. Conduit ends shall be protected during installation. All conduit ends except the outlet and inlets with screens shall be capped with standard factory end caps or concrete. When corrugated plastic tubing is used no more than five (5) percent stretch will be allowed.

Outlet section shall be of rigid pipe and have an animal guard installed.

Trench backfill

Conduits shall be bedded and backfilled as shown on the drawings or described in the specifications. Friable soil material shall be used for blinding around the conduit prior to machine backfilling. The conduit shall not be displaced during backfilling. Mound excess material over the trench.

Trench backfill under the basin embankment or terrace ridge shall be placed in successive 6 inch layers and tamped until a depth of at least 12 inches over the top of the conduit is reached. Water packing of the backfill material may be used in lieu of tamping, except where high clay content (CH) backfill is used. The remainder of the trench shall be sloped to 1.5:1 or flatter and be machine compacted

Inlet installation

The inlet shall be installed as plumb as possible. The maximum length of inlet with holes or slots below channel bottom shall be 6 inches. A trash guard, end cap, or screen shall be installed with each inlet. Backfill shall have sufficient moisture and compaction.

Additional Details:

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Maximum fill height over plastic pipe or tubing = _____ feet

Minimum fill height over plastic pipe or tubing prior to tamping with construction equipment or crossing with heavy equipment such as a loaded scraper = _____ feet